

## **Course Syllabus**

### **ATM 693 Analysis Methods in Meteorology and Climate (3 Credits)**

**Department of Atmospheric Sciences, CNSM**

**University of Alaska Fairbanks**

**Spring 2011 (Jan-May 2011)**

**Instructor:** U. Bhatt (474-2662, [bhatt@gi.alaska.edu](mailto:bhatt@gi.alaska.edu)), IARC 307

**When:** M-W-F 10:00-11:00AM, IARC Room 319

**Office Hours:** M, W—11:00AM-noon and by appointment (send email)

**Course Web page:**

<http://www.gi.alaska.edu/~bhatt/Teaching/ATM693.methods.spring2011/atm693.spring11.html>

**Registration information:** ATM693 CRN: **37045**

**Course Pre-/co-requisites:** ATM 401/601, a basic understanding of statistics, and Programming of some form will be helpful.

### **Course Objectives:**

1. Learn about weather and climate data storage formats. This includes various regular and non-regular ascii formats for observational data and a range of self-describing gridded binary formats, including HDF, GRIB, netCDF. Understand how their dimensionality works. Develop creative ways to read in all kinds of data. Data I/O is the biggest stumbling block to analyzing data!
2. Learn to manipulate programming systems to tackle large data sets. These systems are fundamental tasks of analysis work; familiarity with their operation is essential.
3. Learn about statistical methods to reduce and analyze data sets. Analysis methods frequently utilized in weather and climate research will be explored. This includes standard aggregate reduction statistics, time series analysis, and eigen methods.
4. Learn about extreme event analysis. A frequently requested output is some idea of return intervals of extreme events. We will explore this topic.
5. Learn about model output analysis. Weather and climate models are heavily utilized. Assessment of their output is a critical first step before their results can be folded into research.
6. Results presentation. An important component to this business is presentation of your results, both in oral format as well as in journal format. We will work on issues of presentation via submitted work and class presentations.

### **Materials Needed:**

The course will draw primarily from the following books but will also draw from journal articles and other texts:

- Statistical Methods in the Atmospheric Sciences 2nd ed., by Daniel Wilks (2005), Academic Press, ISBN 978-0127519661.
- Hans von Storch and Francis W. Zwiers; Cambridge. University Press, Cambridge, 1999, x+484pp., ISBN 0-521-45071-3.

- Handbook of Statistical Methods in Meteorology by C. E. P. and N. Carruthers Brooks (Hardcover - 1953)
- Schaum's Outline Series: Statistics Murray R. Spiegel McGraw-Hill.

### Other Tools:

- Access to the programming language of your choice.
- Your favorite math and statistics books.
- Books on reference in Mather Library (list above)

### Course Goals:

Students will gain a fundamental knowledge of how to efficiently construct programs (mixture from scratch and use available open source code) to calculate various quantities needed to analyze large meteorological data sets.

### Student Learning Outcomes:

Students who take this class, participate, do the homework, and attend regularly are expected to have the following skills:

Student learning objectives

By the end of this course students should be able to:

- Describe what a self-describing gridded binary format is and identify major formats currently in use.
- Know how to gain information about such a dataset when presented with one.
- Delve into a dataset to reduce and prepare it for further analysis.
- Perform a variety of standard types of data analysis (e.g. correlations/regressions/EOFs).
- Present project results in a clear and concise manner. This includes readying results for print publication.

**Instructional methods:** This course is based on lectures, which will cover the major topics, emphasizing and discussing the important points. They are not sessions to regurgitate material already written in the text (though they sometimes may be!). The main text book is a general atmosphere-ocean fluids book but specific examples from Holton and Lynch and Cassano will be used to provide atmospheric specific examples. Your personal participation is important, and it is will help you learn more efficiently to read the assigned material to reinforce the lectures. Matlab scripts from various sources may be used to reinforce the material. This will depend on the availability of the university site license and student expertise in Matlab.

### Course Policies:

**Homework:** There will be approximately one homework assignment each 1-2 weeks. The problems will be handed out in class. You are highly encouraged to work with others on the homework, but please make sure that you understand the problems that you hand in. I will randomly ask students to present the homework on the board and the board presentation of the problems will be a part of your homework grade. You will hand in your homework papers after the problems have

been discussed in class on the due date. Due to time constraints, we will not discuss all the homework problems in class, but solutions will be available in a folder box outside my office. **Late problem sets will have grade lowered by 10% per day late.**

**Quizzes:** The quizzes will be closed book. **Quiz 1 is on 25 Feb 2011 and Exam 2 is on 15 April 2011.** Missed exams will be given a 0 grade and make up exams will be given only under extenuating circumstances.

**Class Project:** The class project will entail choosing a problem (mutually agreed upon), writing code to solve it, visualize the results and giving a 30-minute presentation to the class which provides the background, motivation, solution method used and results. Discuss the science learned from the analysis also. You will also write documentation about the code you have written that is understandable for a colleague (and yourself months later). This project should ideally be a task you need to do for your research so that it serves multiple purposes. Finally, you should have a working code that you can use in your research analysis.

**Complaints and Concerns:** You are always welcome to talk to me to express complaints and concerns about the class. I will listen, though I do not guarantee that I will change the way I am doing things.

**Plagiarism etc:** Plagiarism and cheating are matters of serious concern for students and academic institutions. This is true in this class as well. The UAF Honor Code (or Student Code of Conduct) defines academic standards expected at the University of Alaska Fairbanks, which will be followed in this class. (Taken from the UAF plagiarism web site, which has many links with good information about this topic).

**Evaluation:** The course grade will consist of the following components. Final letter grades will be based on a standard scale: A=90 to 100%, B=80% to 89%, C=70% to 79%, D=50% to 69%, and F≤50%. As of Fall 2006, UAF has instituted a +/- scale to the grades, so the bottom and top 3 percentage points will fall within the '-' and '+' ranges, respectively. For example: 90-92% will be an A-, 93-96% will be an A, and above 97% will be an A+. Note that tests will be graded on a curve, so the above scale may be modified.

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Homework	30%
Quiz 1	15%
Quiz 2	15%
Semester Project	40%

**Additional References:** Relevant papers and chapter references will be made available during the semester.

**General Course Subjects:**

1. Data storage methods (types of data formats and how best to deal with them) – observations and model data
2. Elementary statistics
  - Correlation, Regression, Epoch, Statistical Significance
4. Eigenmode analysis methods
  - EOFs, SVDs
5. Time series analysis
  - Autocorrelation, spectral analysis, filtering
6. Error and uncertainty analysis
7. Parametric vs non-parametric methods
8. Extreme value analysis
9. Dynamical analysis (e.g. storm track statistics, EP fluxes)
10. Introduction to uses of GIS for Meteorological analysis

**General Advice:** This class will focus on developing a library of methodologies to solve various types of calculation problems. Try the following study procedure:

1. Read the assigned materials. There will be some chapters in books but also journal articles.
2. The classroom notes will describe the background and methodology for doing various standard calculations. We will draw upon journal articles also to learn about how the Meteorological community deals with certain issues (e.g. errors, uncertainty, or missing data).
3. You will develop good coding skills and improve your debugging skills.

### **Disabilities Services:**

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. We will work with the Office of Disabilities Services (203 WHIT, 474-7043) to provide reasonable accommodation to students with disabilities.